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(71)Applicant : KAWASAKI STEEL CORP

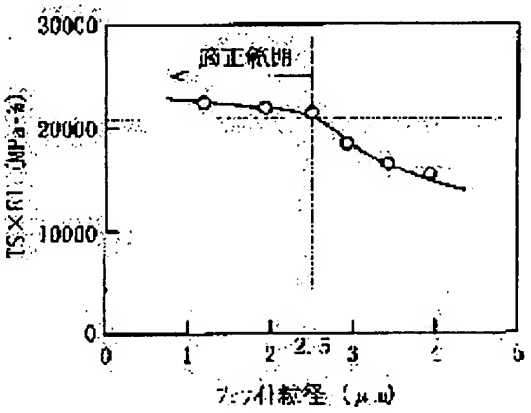
(72)Inventor : SETO KAZUHIRO
SHIMIZU TETSUO
FURUKIMI OSAMU

(54) HIGH STRENGTH THIN STEEL SHEET AND HIGH STRENGTH GAVLANIZED THIN STEEL SHEET EXCELLENT IN DUCTILITY AND LOW IN YIELD RATIO AND PRODUCING METHOD THEREFOR

(57)Abstract:

PROBLEM TO BE SOLVED: To provide a high strength thin steel sheet combining the good balancing characteristics of strength-elongation of TS×El of 21,000 MPa.% or more and YR of 70% or less and a low yield ratio.

SOLUTION: In this thin steel sheet having a composition containing, by mass, 0.05 to 0.25% C, 0.1 to 2.0% Si 0.5 to 2.0% Mn, 0.05 to 0.3% Ti and ≤0.10% Al, and the balance Fe with inevitable impurities and a steel structure composed of the main phase consisting of polygonal ferrite and a second phase consisting of martensite and/or retained austenite, the average crystal grain diameter of the polygonal ferrite is controlled to 0.8 to 2.5 μm, moreover, the second phase is distributed so as to be reticulately connected to the grain boundary of the polygonal ferrite, moreover, the occupying volume rate of the second phase is controlled to 5 vol.% or more, and the width of



the second phase is controlled to 0.4 μm or less on the average.

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CLAIMS

[Claim(s)]
[Claim 1] With mass percentage, C:0.05 - 0.25%, Si:0.1 - 2.0 %, Mn: The main phase which 0.5 - 2.0 %, Ti:0.05-0.3 %, and less than [aluminum:0.10%] are contained, and the remainder becomes the presentation of Fe and an unescapable impurity, and consists of a poly GONARU ferrite, It has the steel organization which consists of the 2nd phase which consists of martensite and/or retained austenite. The diameter of average crystal grain of the above-mentioned poly GONARU ferrite 0.8 micrometers Above 2.5 micrometers Following, The 2nd phase of the above connects with the grain boundary of the above-mentioned poly GONARU ferrite in the shape of a mesh, and is distributed over it. Moreover, the space factor of the 2nd phase of the above moreover, more than 5 vol% and less than [20vol%] And the width of face of the 2nd phase of the above is on an average. 0.4 micrometers It excels in the ductility characterized by being the following, and is the low high intensity sheet steel of a yield ratio.
[Claim 2] It excels in the ductility to which steel is further characterized by becoming the presentation containing one sort chosen from from in [B:0.00002 - 0.01% of] below Cu:1.0 %, below Mo:1.0 %, below nickel:1.0 %, and below Cr:1.0 %, or two sorts or more P:0.05% or less below Nb:0.1 % and below V:0.5 % with mass percentage in claim 1, and is the low high intensity sheet steel of a yield ratio.
[Claim 3] It excels in the ductility characterized by offering a galvanization layer or an alloying galvanization layer on a steel plate front face in claims 1 or 2, and is the low high intensity galvanization sheet steel of a yield ratio.
[Claim 4] With mass percentage, C:0.05 - 0.25%, Si:0.1 - 2.0 %, Mn:0.5 - 2.0 %, Ti:0.05-0.3 %, and less than [aluminum:0.10%] are contained. Further Or below Nb:0.1 %, below V:0.5 %, P:0.05% or less, Cu: Below 1.0 %, below Mo:1.0 %, and below nickel:1.0 % Cr: The main phase which one sort chosen from from in [B:0.00002 - 0.01% of] below 1.0 % or two sorts or more are contained, the remainder becomes the presentation of Fe and an unescapable impurity, and a steel organization becomes from the poly GONARU ferrite, It consists of the 2nd phase which consists of one sort chosen from from among a pearlite, bainite, martensite, and retained austenite, or two sorts or more. The diameter of average crystal grain of the above-mentioned poly GONARU ferrite is 0.8 micrometers. Above 2.5 micrometers The following sheet steel With the programming rate of 1 degrees C/s or more It heats to the temperature requirement of 730 - 780 **. It excels in the ductility which holds for 1 - 20 seconds to whenever [this stoving temperature], and is characterized by cooling below to the Ms point succeedingly decided by the following formula with the average cooling rate of 5 degrees C/s or more, and is the manufacture approach of the low high intensity sheet steel of a yield ratio.
Account Ms (degree C) = 561-474, -33, Mn(%)-17, and nickel (%)
- 17, Cr(%)-21, and Mo (%)
[Claim 5] In claim 4, it excels in the ductility characterized by performing hot-dip-zincing processing to the above-mentioned sheet steel at the process which cools, and is the manufacture approach of the low high intensity galvanization sheet steel of a yield ratio.
[Claim 6] After ending cooling in claim 5, it is the above-mentioned sheet steel. It holds for 20 - 60 seconds by 450 - 500 **, excels in the ductility characterized by alloying a hot-dip-zincing layer, and is

the manufacture approach of the low high intensity galvanization sheet steel of a yield ratio.

[Translation done.]

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DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Field of the Invention] The use as a steel plate for automobiles is presented especially with this invention, and it is excellent in suitable ductility, and moreover, it reaches and they are the low high intensity sheet steel of a yield ratio, and a thing about high intensity galvanization sheet steel and those manufacture approaches.
[0002]
[Description of the Prior Art] From a viewpoint of improvement in the safety at the time of reduction of the fuel consumption of an automobile, and a collision, the steel plate used for the car body of an automobile is asked for attaining high-intensity-izing and the Takanobu nature-ization to coincidence. The TRIP steel which has the organization which consists of the dual-phase-steel plate (it is hereafter called DP steel) which has the organization which makes a ferrite and martensite a subject as steel developed for such the purpose, a ferrite and bainite, and retained austenite is known.
[0003] DP steel among the above-mentioned steel is yield ratio YR(= yield strength YS / tensile strength TS) x100. Although it is as low as 70% or less and being excelled in configuration freezing nature, it is inferior to TRIP steel in respect of ductility, and it is the balance (TSxEl) of the reinforcement and ductility. 19000 MPa and % extent were limitations. On the other hand, TRIP steel shows the Takanobu nature by retained austenite metamorphosing into martensite at the time of deformation, and TSxEl . It is possible to exceed 20000 MPa and %.
[0004] for example, to JP,3-10049,A The steel which contains C, Si, and Mn as a fundamental component More than rolling reduction:80% Heat finish rolling is carried out by 780 - 900 **. Rolling termination temperature : After finish rolling termination, By starting cooling with the cooling rate of less than 40 degrees C/s, ending cooling at the predetermined temperature decided from finish rolling temperature or a finish rolling rate, cooling more than in cooling rate:40 degree-C/s subsequently, and rolling round by 350 - 500 ** The space factor of the poly GONARU ferrite and the ratio of particle size 61% or less or more by 18 [the space factor of the poly GONARU ferrite] And the manufacture approach of hot rolled sheet steel of having the 2nd phase which consists of bainite and retained austenite, and having the steel organization whose retained austenite in this 2nd phase is 5% or more is indicated. And it is possible to attain TSxEl=20000MPa and % extent in this hot rolled sheet steel.
[0005] Moreover, consider as TSxT.El>=2000 kgf/mm2and% (19600MPaand%), and it aims at obtaining the hot rolled sheet steel which raised elongation flange nature further to JP,9-104947,A. C:0.05 - 0.15 % of the weight, and Si:0.5 -3.0 Weight %, Mn: 0.5 -3.0 Weight %, P<=0.02 % of the weight, S<=0.01 % of the weight, The steel which uses aluminum:0.005 -0.10 % of the weight and Fe as a principal component By in hot-rolling, the rate of the bottom of total pressure performing 80% or more of finish rolling for finish rolling termination temperature as range of 3+50 degree C of Ar3-50-Ar(s), and performing one-step cooling, two-step cooling, or three-step cooling after finish rolling termination It consists of three phase circuits of a ferrite, bainite, and retained austenite, and the ratio (VF/dF) of a ferrite space factor (VF) and ferrite particle size (dF) is 2 micrometers or more in 20. The technique of

obtaining the steel organization where the following retained austenite space factors become 5% or more is indicated.
[0006]
[Problem(s) to be Solved by the Invention] However, steel plate reinforcement for the formation of car-body lightweight of an automobile It is 590 MPa if one gage tends to be downed in what is 400 MPa class. The high intensity steel plate with which it has the above high reinforcement, and TSxEl exceeds 21000MPa(s) and % is needed. TSxEl of the steel plate of the indication to this point and above-mentioned JP,3-10049,A It is 20000 MPa and % extent, and this demand is not filled. Moreover, TSxEl at JP,9-104947,A. Although the example exceeding 21000 MPa and % was indicated, even if the yield ratio YR was low, it was about 70%, at the time of press working of sheet metal, a big load is applied, or big springback arises, the problem of the dimensional accuracy of components falling is included, and there was a problem in utilization.
[0007] Therefore, tensile strength TS by the split which is 1.4 mm extent It is more than 590 MPa, and TSxEl . It has the on-the-strength-elongation balance 21000 MPa and more than %, and if the steel plate whose yield ratio YR is moreover 70% or less, i.e., the high intensity steel plate which has the description of DP steel and TRIP steel, can be manufactured, lightweight-ized ****** of an automobile will become possible [contributing to improvement in energy greatly]. [board thickness] Then, this invention aims at proposing TS>=590 MPa, the sheet steel which is TSxEl>=21000MPaand% and has the outstanding property of yield ratio <=70%, and galvanization sheet steel with those manufacture approaches.
[0008]
[Means for Solving the Problem] Now, Ti is used as an indispensable component as a result of repeating research wholeheartedly that artificers should attain the above-mentioned purpose. By quenching, after making detailed the ferrite generated in a hot rolling process and carrying out short-time heating of the hot rolled sheet steel further obtained according to this hot rolling process in a two-phase region It becomes the main phase which consists of a very detailed ferrite from martensite and retained austenite. It came to complete a header and this invention for the ability of marked improvement in on-the-strength-elongation balance to be aimed at, while it could consider as the steel organization which has the 2nd phase distributed over the grain boundary of a ferrite in the shape of a mesh and this had kept the yield ratio low.
[0009] That is, the summary configuration of this invention is as follows.
With Mass Percentage, 1. C:0.05 - 0.25%, Si:0.1 - 2.0 %, Mn: The main phase which 0.5 - 2.0 %, Ti:0.05-0.3 %, and less than [aluminum:0.10%] are contained, and the remainder becomes the presentation of Fe and an unescapable impurity, and consists of a poly GONARU ferrite, It has the steel organization which consists of the 2nd phase which consists of martensite and/or retained austenite. The diameter of average crystal grain of the above-mentioned poly GONARU ferrite 0.8 micrometers Above 2.5 micrometers Following, The 2nd phase of the above connects with the grain boundary of the above-mentioned poly GONARU ferrite in the shape of a mesh, and is distributed over it. Moreover, the space factor of the 2nd phase of the above moreover, more than 5 vol% and less than [20vol%] And the width of face of the 2nd phase of the above is on an average. 0.4 micrometers It excels in the ductility characterized by being the following, and is the low high intensity sheet steel of a yield ratio.
[0010] 2. Excel in the ductility to which steel is further characterized by becoming the presentation containing one sort chosen from from in [B:0.00002 - 0.01% of] below Cu:1.0 %, below Mo:1.0 %, below nickel:1.0 %, and below Cr:1.0 %, or two sorts or more P:0.05% or less below Nb:0.1 % and below V:0.5 % with mass percentage in the above 1, and it is the low high intensity sheet steel of a yield ratio.
[0011] 3. Excel in the ductility characterized by offering a galvanization layer or an alloying galvanization layer on a steel plate front face in the above 1 or 2, and it is the low high intensity galvanization sheet steel of a yield ratio.
[0012] With Mass Percentage, 4. C:0.05 - 0.25%, Si:0.1 - 2.0 %, Mn:0.5 - 2.0 %, Ti:0.05-0.3 %, and less than [aluminum:0.10%] are contained. Further Or below Nb:0.1 %, below V:0.5 %, P:0.05% or less,

Cu: Below 1.0 %, below Mo:1.0 %, and below nickel:1.0 % Cr: The main phase which one sort chosen from from in [B:0.00002 - 0.01% of] below 1.0 % or two sorts or more are contained, the remainder becomes the presentation of Fe and an unescapable impurity, and a steel organization becomes from the poly GONARU ferrite, It consists of the 2nd phase which consists of one sort chosen from from among a pearlite, bainite, martensite, and retained austenite, or two sorts or more. The diameter of average crystal grain of the above-mentioned poly GONARU ferrite is 0.8 micrometers. Above 2.5 micrometers The following sheet steel With the programming rate of 1 degrees C/s or more It heats to the temperature requirement of 730 - 780 **. It excels in the ductility which holds for 1 - 20 seconds to whenever [this stoving temperature], and is characterized by cooling below to the Ms point succeedingly decided by the following formula with the average cooling rate of 5 degrees C/s or more, and is the manufacture approach of the low high intensity sheet steel of a yield ratio.
Account Ms (degree C) = 561-474, -33, Mn(%)-17, and nickel (%)
- 17, Cr(%)-21, and Mo (%)
[0013] 5. Excel in the ductility characterized by performing hot-dip-zincing processing to the above-mentioned sheet steel at the process which cools in the above 4, and it is the manufacture approach of the low high intensity galvanization sheet steel of a yield ratio.
[0014] 6. After ending cooling in the above 5, it is the above-mentioned sheet steel. It holds for 20 - 60 seconds by 450 - 500 **, excels in the ductility characterized by alloying a hot-dip-zincing layer, and is the manufacture approach of the low high intensity galvanization sheet steel of a yield ratio.
[0015] In addition, when not adding these elements positively, even if it asks for the above-mentioned Ms point using the content of these elements in unescapable impurity level, it may ask for an Ms point by making these contents into zero, or any are sufficient, although the term containing the content of nickel, Cr, and Mo is in the above-mentioned formula which asks for an Ms point.
[0016]
[Embodiment of the Invention] Hereafter, an experimental result is explained [which came to originate this invention]. With mass percentage, C:0.14% and Si:0.7 %, Mn:1.2 %, P:0.010 %, S:0.002 %, aluminum:0.042 %, and Ti:0.16% were contained, and the remainder manufactured hot rolled sheet steel by being made from the steel which becomes the presentation of Fe and an unescapable impurity. here -- hot rolling -- whenever [stoving temperature] -- :1080 degree C -- rough -- it considered as rolling termination temperature:1000 degree C and finish rolling termination temperature:860 **, and rolled out to board thickness:1.4 mm. Moreover, cooling is started with the cooling rate of 80 degrees C/s after finish rolling termination and 0.8 seconds, and it is rolling-up temperature. It could be 500 degrees C. In addition, as a result of carrying out finish rolling with the continuous mill of seven stands and measuring the rolling load of each stand at the time of finish rolling, it checked that it was rolling in a dynamic recrystallization region up to preceding paragraph 5 stand. About the obtained hot rolled sheet steel, when it gazes at a steel organization, mean particle diameter 1.8 micrometers The main phase which consists of a poly GONARU ferrite, and mean particle diameter 0.3 micrometers He was the diplophase organization which has the 2nd phase which consists of a pearlite and a cementite. About the steel plate which gave various heating / cooling cycles to this steel plate, while observing fine ******, the tension test was performed and the value of the tensile strength TS x (MPa) elongation El (%) was calculated.
[0017] The result investigated about the effect of the diameter of average crystal grain of the poly GONARU ferrite after heating / cooling processing exerted on drawing 1 at TSxEl (it is called ferrite particle size below) is shown. Here, it asked for ferrite particle size with the intercept method based on JIS G 0552. It is about TSxEl as shown in this drawing. In order to carry out to more than 21000 MPa and %, it is ferrite particle size. 2.5 micrometers It turns out that it is necessary to consider as the following.
[0018] In addition, the 2nd phase after heating / cooling processing was an organization where a space factor (rate of the volume) consists of 10 - 17 vol% martensite and retained austenite. moreover, ferrite particle size 2.5 micrometers the case where it is the following -- the 2nd phase -- a ferrite grain boundary -- the shape of a mesh -- connecting -- being distributed -- **** -- the width of face of the 2nd phase -- average 0.1-0.4 mum it was . On the other hand, ferrite particle size 2.5 micrometers When

exceeding, the 2nd phase was distributed massive. Furthermore, TSxEl The steel plate which becomes more than 21000 MPa and % also checked that a yield ratio YR was 70% or less.
[0019] Drawing 2 shows the effect of the space factor of the 2nd phase exerted on TSxEl. All over this drawing, although the case where it was distributed massive with the case where the 2nd phase connects with a ferrite grain boundary in the shape of a mesh, and is distributed over it was shown, in order to satisfy TSxEl>=21000MPa and %, the shape of a mesh connects in a ferrite grain boundary, and the 2nd phase is distributed, and it is the space factor of the 2nd phase More than 5vol% It turns out that it is necessary to consider as less than [20vol%]. In addition, when the space factor of the 2nd phase was less than [5 vol%], the 2nd phase was not distributed in the shape of a mesh, and massive distribution was shown. here -- ferrite particle size 1.7 micrometers it is -- moreover, width of face of the 2nd phase in the case of the 2nd phase consisting of martensite and retained austenite, and this 2nd phase connecting in the shape of a mesh, and being distributed 0.1-0.4 mum it was .
[0020] Drawing 3 is drawing showing the effect the average of the width of face of the 2nd phase in the case of the 2nd phase connecting in the shape of a mesh, and being distributed over the ferrite grain boundary affects TSxEl. The average of the width of face of the 2nd phase 0.4 micrometers When it is the following, TSxEl . It turns out that it becomes more than 21000 MPa and %. In addition, ferrite particle size 1.6-2.0 mum The 2nd phase consisted of martensite and/or retained austenite, and the space factor of the 2nd phase was 12 - 15 vol%.
[0021] From the above result, in order to carry out TSxEl to more than 21000MPa(s) and % It is [the main phase which consists of a poly GONARU ferrite, and] more than 5vol% at a space factor. It has the 2nd phase which consists of the martensite and/or retained austenite not more than 20vol%, and ferrite particle size 2.5 micrometers Below And the 2nd phase connects with a ferrite grain boundary in the shape of a mesh, and is distributed over it, and the width of face of the 2nd phase of a parenthesis is on an average. 0.4 micrometers It turned out [fine ****** which becomes the following, then] that it is good.
[0022] Then, manufacture conditions for such TSxEl to obtain a high organization were examined below. Now, artificers noted performing organization control of the 2nd phase by performing heating / cooling processing to this by being made from the steel plate which is the steel organization which has the 2nd phase which consists of one sort chosen from from among the main phase which consists of a poly GONARU ferrite, a pearlite and bainite, martensite, and retained austenite, or two sorts or more.
[0023] Ferrite particle size of the steel plate which serves as a material with which this heating / cooling processing is presented here since ferrite particle size cannot be made detailed by heating / cooling processing It is necessary to be 2.5 micrometers or less. Although not limited, after it ingots the approach indicated by JP,11-152544,A, for example, i.e., the material for hot rolling, especially the method of obtaining the material of such an organization hot-rolls by ******(ing) **** 1 immediately and heating at 1200 degrees C or less, and in that case, the approach the pressing-down pass of five or more stands performs the draft in a dynamic recrystallization region divides it, and it suits advantageously.
[0024] Here, simple heat treatment called heating and cooling was performed to the hot rolled sheet steel of board thickness:1.4 mm mentioned above. First, in order that the soak temperature and the soaking time at the time of heating may investigate the effect affect TSxEl and YR, the programming rate at the time of heating is carried out in 5 degrees C/s, and soaking is performed in various soak temperature and soaking times, and subsequently it is the cooling rate of 20 degrees C/s. It cooled to 300 degrees C or less. Here, the purpose which cools below to 300 ** is a martensitic transformation point (Ms point). It is for cooling to 455 degrees C or less, and making the 2nd phase into martensite and/or retained austenite. About the steel plate after the above-mentioned heat treatment, the result of having measured the TSxEl and YR value is shown in drawing 4 . In order to consider as TSxEl>=21000MPaand% as shown in this drawing, it turns out that it is necessary make soak temperature into 730-780 **, and to make a soaking time into 1 - 20 seconds.
[0025] in order [moreover,] to investigate the effect the programming rate at the time of heating affects TSxEl -- soak temperature -- 750 ** and a soaking time -- the cooling rate after 10 seconds and soak --

20 degrees C/[s and] and cooling termination temperature 300 degrees C or less -- it presupposed that it is fixed, and only various programming rates are boiled, were changed, and heating / cooling processing was performed. TSxEl of the steel plate obtained in this way is measured, and relation with a programming rate shows the result to drawing 5 . In order to consider as TSxEl>=21000MPaand% as shown in drawing 5 , it turns out that it is necessary to carry out a programming rate in 1 degrees C/s or more.

[0026] Next, in order to investigate the effect the cooling rate in the cooling processing after soak affects TSxEl, they are 5 degrees C/[s and] and soak temperature about the programming rate at the time of heating. After heat-treating by making 750 degrees C and a soaking time into 10 seconds, they are various cooling rates. It cooled to 300 degrees C or less. About the steel plate obtained in this way, TSxEl is measured and relation with a cooling rate shows the result to drawing 6 . Unless the cooling rate in the case of cooling processing was 5 degrees C/s or more as shown in this drawing, TSxEl was not able to be carried out to more than 21000MPa(s) and %.

[0027] In order to investigate the effect of Ti content exerted on TSxEl, with mass percentage Next, C:0.13%, S:0.002 % and aluminum:0.042 % are contained as a fundamental component Si:0.7 %, Mn:1.2 %, and P:0.01%. They are rolling termination temperature:1000 degree C and finish rolling termination temperature:860 **. and the steel with which Ti is contained with various additions and the remainder becomes the presentation of Fe and an unescapable impurity -- whenever [stoving temperature] -- :1080 degree C -- rough -- And it is the conditions of [stand / at the time of finish rolling / preceding paragraph 5] rolling in a dynamic recrystallization region, and is board thickness:1.4mm. It rolled out. It is after finish rolling termination and 0.8 in that case. Cooling is started with the cooling rate of 80 degrees C/s in a second, and it is rolling-up temperature. It could be 500 degrees C. FIRAITO particle size with the above-mentioned hot rolling 2.0 micrometers The main phase which consists of a poly GONARU ferrite, and the diameter of average crystal grain 0.3 micrometers The steel plate of the diplophase organization which consists of the 2nd phase which consists of a pearlite or a cementite was obtained.

[0028] And the obtained steel plate was heated in programming-rate:5 degree-C/s, and it cooled in cooling rate:10 degree-C/s to 300 degrees C or less after performing soaking for 18 seconds by 760 **. About the steel plate obtained in this way, TSxEl is measured and relation with Ti content shows the result to drawing 7 . It is Ti, in order to consider as TSxEl>=21000MPaand% as shown in this drawing More than 0.05mass% It understands that it is necessary to make it contain in not more than 0.3mass%.

[0029] In addition, the main phase which all become from the poly GONARU ferrite when fine ****** of the steel plate with which TSxEl>=21000MPa and % were obtained is investigated in drawing 4 -7, the 2nd phase which consists of martensite and/or retained austenite -- a space factor -- 5 - 20 vol% -- the existing steel organization -- having -- diameter of average crystal grain of the poly GONARU ferrite 0.8 micrometers The above 2.5 micrometers Below The 2nd phase connects with the grain boundary of said poly GONARU ferrite in the shape of a mesh, and is distributed over it, and, moreover, the width of face of the 2nd phase is on an average. 0.4 micrometers Having satisfied the following was checked.

[0030] Next, in this invention, the reason which limited the component presentation of steel to the aforementioned range is explained.

C: 0.05-0.25mass%C promotes generation of an austenite at the time of heating to a two-phase region, is an element required in order to make cooling following this generate martensite and/or retained austenite, and needs to add 0.05mass(es)% at least while it heightens the effectiveness of Ti by formation of TiC. However, if there are too many amounts of C, since degradation of weldability will be caused, let 0.25mass(es)% be an upper limit.

[0031] since Si:0.1 -2.0 mass%Si has the effectiveness which promotes generation of an austenite at the time of heating to a two-phase region -- at least -- 0.1 mass% -- it adds. However, it is since the effectiveness is saturated even if it adds exceeding 2.0 mass%, and a cost rise is caused. Let 2.0mass% be an upper limit.

[0032] Mn: By heating to a two-phase region, and subsequent cooling, 0.5 -2.0 mass%Mn is required in order to make the 2nd phase into martensite and/or retained austenite, and it needs 0.5 mass% of

addition at least. However, since too much addition decreases the temperature width of face of a two-phase region and it becomes impossible to obtain a desired organization, it makes an upper limit 3.0 mass%.

[0033] Ti: 0.05-0.3 mass%Ti is the most important element in this invention. Ti is a phase before heating at the time of heating / cooling processing, exists as TiC and prevents coarsening at the time of heating. Moreover, since it exists in a ferrite grain boundary minutely, when many of TiC(s) are heated to a two-phase region, it acts as a source of C, and is considered with making the mesh-like 2nd phase appear succeeding a grain boundary. Although the reason such an organization raises TSxEl is not clear, since the 2nd hard whole phase is connected, while it also equalizes deformation of the 2nd phase and strengthening by the 2nd phase acts advantageously, it is presumed because the crack generation between the main phase and the 2nd phase which consist of an elastic ferrite is controlled. In order to acquire the effectiveness of the 2nd phase which the shape of a mesh connected with such a ferrite grain boundary, 0.05mass(es)% needs to be Ti added at least. However, if it adds so much exceeding 0.3 mass%, since the effect of solid solution strengthening by Ti itself or precipitation strengthening by TiC will become strong and will reduce TSxEl, let 0.3 mass% be an upper limit.

[0034] aluminum: Less than [0.10mass%] aluminum can be added in not more than 0.10mass% as a deoxidizer. Even if it adds exceeding 0.10mass(es)%, effectiveness is saturated, and also the fall of arc welding nature is caused.

[0035] As mentioned above, although the indispensable component was explained, in addition to this, the element described below can be made to contain suitably in this invention.

Nb: If there are too many additions, since recrystallization will be checked remarkably, will make it hard and the quality of the material will deteriorate, make it contain in not more than 0.1 mass%, although less than [0.1 mass%] Nb is an element effective in high-intensity-izing steel by precipitation strengthening.

[0036] V: Less than [0.5 mass%] V is not only effective in high-intensity-izing steel by precipitation strengthening, but has the operation which promotes generation of martensite by heating to a two-phase region, and subsequent cooling. However, since a lot of addition causes a ductile fall, 0.5 mass% shall be added as an upper limit.

[0037] P: Although it is not necessary to add, if especially less than [0.05mass%] P is addition to about 0.05mass%, since it will contribute effective in the improvement in on the strength of a steel plate, without causing secondary elaboration embrittlement, it can add 0.05mass% as an upper limit.

[0038] Cu, Mo, nickel, Cr : respectively Less than [1.0mass%] Cu, Mo, and nickel and Cr are effective in high-intensity-izing of the steel by solid solution strengthening and organization strengthening respectively. However, an addition all Since hot-working nature will fall if 1.0mass% is exceeded, it is possible respectively independent in not more than 1.0 mass% or to carry out compound addition.

[0039] B: 0.0002-0.01mass%B acts effective in organization strengthening of steel in the addition range beyond 0.0002mass%. However, since it is prevented remarkably, and recrystallization will make it hard and will cause degradation of the quality of the material if an addition exceeds 0.01mass(es)%, it shall add in 0.0002 - 0.01mass%.

[0040] S: Although especially less than [0.01mass%] S does not limit, since ductility will fall if the amount of S mixed unescapable is extremely high, controlling less than [0.01mass%] is desirable.

[0041] Next, the reason for limitation of a steel organization is explained.

It is necessary to make the poly GONARU ferrite into the main phase in main phase this invention which consists of a poly GONARU ferrite. The poly GONARU ferrite is rich in ductility by elasticity, and this reason is because it is useful although the ductility of an ingredient is secured. In addition, the main phase is a space factor (rate of the volume). It means that it is more than 50vol%.

[0042] The diameter of average crystal grain of the poly GONARU ferrite: 0.8 mum Above 2.5 micrometers Connect the 2nd phase in the shape of a mesh, it is made to generate below, and TSxEl . In order to be more than 21000 MPa and % and to make YR into 70% or less, it is the diameter of average crystal grain of the poly GONARU ferrite. 2.5 micrometers It is necessary to consider as the following. Minimum of the ferrite particle size which can be attained in present hot rolling or a present cold rolling

process on the other hand 0.8 micrometers Since it is extent 0.8 micrometers It considers as a minimum.
[0043] It is necessary to make the space factor of the 2nd phase, a gestalt, and the 2nd width-of-face hard phase connect with the grain boundary of the poly GONARU ferrite in the shape of a mesh, and to make them exist in it. As mentioned above, it is that the 2nd hard phase connects, and this is because generating of the crack between the main phase and the 2nd phase can be effectively controlled during deformation while it can attain high intensity-ization more effectively. Moreover, when the 2nd phase has connected in the shape of a mesh, it is because the movable rearrangement in the poly GONARU ferrite which is generated in case the 2nd hard phase generates and which originated distorted increases and it contributes also to reduction of a yield ratio. However, since connection of such 2nd phase does not arise [the space factor of the 2nd phase] less than [5 vol%], but the molar fraction of the 2nd phase becomes high too much by 20 vol% ** on the other hand and the ductility of the main phase falls victim, the space factor of the 2nd phase is limited to the range of 5 - 20 vol%.
[0044] Moreover, the average of the distance to the boundary of the 2nd phase of the opposite side and the main phase this boundary from a boundary with the average of the width of face of the 2nd phase, i.e., a certain 2nd phase, and the main phase 0.4 micrometers If it exceeds, since the structure of the 2nd connected phase will become firm too much and a ductile fall will be brought about, the width of face of the 2nd phase is on an average. 0.4 micrometers It considers as the following. Furthermore, in order to give reinforcement to a steel plate, it is necessary to consider the 2nd phase as the organization which consists of one of the retained austenites made hard according to hard martensite or deformation, or both.
[0045] Next, the manufacture conditions for obtaining the steel organization which mentioned above are described. In this invention, as mentioned above, the diameter of average crystal grain 0.8-2.5 mum The main phase which consists of a poly GONARU ferrite, Are made from the steel plate which becomes the steel organization which has the 2nd phase which consists of one sort chosen from from among a pearlite, bainite, martensite, and retained austenite, or two sorts or more. Heating / cooling processing, i.e., the heating process beyond programming-rate:1 degree-C/s, soak temperature : 730 - 780 **, Soaking time: Perform organization control of the 2nd phase by carrying out the soak process for 1 - 20 seconds, and the cooling process cooled below at a martensitic transformation point (Ms point) in more than cooling rate:5 degree-C/s.
[0046] under the present circumstances -- the manufacture approach of the above-mentioned material -- hot-rolling and cold-rolling -- although which process may be used and is not limited especially, the approach indicated by above-mentioned JP,11-152544,A, for example suits advantageously. That is, the molten steel ingoted in the predetermined component presentation range is used as slab, and they are the approach ******, heat at 1200 degrees C or less, face [hot-rolling subsequently and], and the pressing-down pass of five or more stands performs the draft in a dynamic recrystallization region, and a method of giving annealing further succeedingly ** 1 immediately after that again after rolling reduction:50-90% of cold rolling, and in the temperature requirement of 600 degree C - three Ac(s).
[0047] Hereafter, heating / cooling processing conditions are explained.
Programming rate: If the programming rate in s 1-degree-C [/] or more heating processes is not filled [s] in 1 degree C /, since it becomes impossible to obtain the 2nd phase in which the ferrite carried out grain growth and which it connected in the shape of a mesh into the temperature up and reservation on the strength becomes impossible, carry out a programming rate in 1 degrees C/s or more.
[0048] Soak temperature: It is necessary to perform heat-treatment in a two-phase region for 730 - 780 ** and soaking-time: 1 to 20 seconds, and limit soak temperature to 730 - 780 ** from a presentation and the 2nd phase molar fraction of steel. Moreover, since big-and-rough-izing of an organization and agglomeration of the 2nd phase will advance if the soaking time in the above-mentioned soak temperature cannot make the 2nd phase of an initial complement generate but exceeds 20 seconds on the other hand in less than 1 second, a soaking time is limited to 1 - 20 seconds.
[0049] Average cooling rate: In the cooling process after a cooling soak process, the average cooling rate below an Ms point cannot make [degrees C / // less than 5] the 2nd phase martensite and/or retained austenite in s below at an Ms point in s in 5 degrees C /or more. Therefore, an average cooling

rate is carried out in 5 degrees C/s or more. Moreover, since the 2nd phase could not be made into martensite and/or retained austenite unless it cooled below to the Ms point, the above-mentioned forced-cooling termination temperature was made below into the Ms point. Here, it shall ask for an Ms point by the following formulas. However, since it is a minute amount though you may calculate as each content analyzed as an unescapable impurity and being contained unescapable when not adding nickel, Cr, and Mo positively, each content may be calculated as 0%.
Ms (degree C) = 561-474, -33, Mn(%)-17, and nickel (%)
- 17, Cr(%)-21, and Mo (%)
[0050] In addition, a desired organization can be obtained, if the average cooling rate below an Ms point is [s] securable in 5 degrees C /or more even if it gives hot dip zincing in the middle of this cooling process. Furthermore, since a desired organization will once appear if it cools below to an Ms point, in order to alloy hot dip zincing Even if it adds the process which change of an organization does not have even if it holds for 20 to 60 seconds to 450 - 500 **, and alloys hot dip zincing, it is satisfactory at all.
[0051] Although not limited especially about the facility which carries out heating / cooling processing in which it explained above, a continuous annealing furnace, the hot-dip-zincing facility with an annealing furnace, etc. fit this.
[0052]
[Example] Hot rolling was presented, after ingoting with the converter the steel which becomes the component presentation shown in Table 1 and using it as slab by continuous casting. After heating at 1080 degrees C, it rolls out to 1.4 mm thickness as finish rolling termination temperature:900 **, and hot rolling is from rolling termination. It cooled at 80 degrees C/s in rate after 0.8 seconds, and rolled round by 550 **. Heating / cooling processing was performed on the conditions which show the hot rolled sheet steel obtained by this hot rolling in Table 2 with a continuous annealing furnace. In addition, the inside of Table 2 and No.18 If attached, hot-dip-zincing processing was performed in the middle of cooling processing. Moreover, No.19 If it attaches, while performing hot-dip-zincing processing in the middle of cooling processing, after ending cooling processing 480 degrees C and alloying heat treatment for 40 seconds were performed.
[0053]
[Table 1]

鋼記号	成分組成 (mass%)														備考
	C	Si	Mn	Ti	Al	P	S	Nb	V	Cu	Mo	Ni	Cr	B	
A	0.05	0.9	1.6	0.11	0.042	0.018	0.003	—	—	—	—	—	—	—	適合例
B	0.09	0.7	1.2	0.13	0.044	0.012	0.005	—	—	—	—	—	—	—	〃
C	0.13	1.0	1.0	0.18	0.038	0.015	0.003	—	—	—	—	—	—	—	〃
D	0.14	0.3	1.5	0.16	0.045	0.016	0.004	—	—	—	—	—	—	—	〃
E	0.25	0.7	0.6	0.22	0.051	0.012	0.006	—	—	—	—	—	—	—	〃
F	0.03	0.2	1.4	0.18	0.053	0.016	0.005	—	—	—	—	—	—	—	比較例
G	0.12	0.04	1.8	0.14	0.052	0.017	0.005	—	—	—	—	—	—	—	〃
H	0.11	1.1	0.4	0.18	0.040	0.014	0.007	—	—	—	—	—	—	—	〃
I	0.11	0.9	0.8	0.02	0.044	0.012	0.008	—	—	—	—	—	—	—	〃
J	0.12	1.0	0.9	0.35	0.048	0.015	0.005	—	—	—	—	—	—	—	〃
K	0.08	0.9	1.4	0.15	0.061	0.034	0.003	—	—	—	—	—	—	—	適合例
L	0.12	1.1	1.0	0.16	0.050	0.015	0.004	0.05	—	—	—	—	—	—	〃
M	0.15	1.2	0.9	0.18	0.042	0.014	0.005	—	0.3	—	—	—	—	—	〃
N	0.13	1.2	1.1	0.19	0.048	0.016	0.003	—	—	0.7	—	—	—	—	〃
O	0.14	1.4	1.2	0.18	0.047	0.015	0.008	—	—	—	0.8	—	—	—	〃
P	0.12	1.5	1.4	0.17	0.039	0.013	0.007	—	—	—	—	0.8	—	—	〃
Q	0.15	0.8	1.5	0.20	0.049	0.015	0.006	—	—	—	—	—	0.4	—	〃
R	0.14	0.9	1.3	0.16	0.042	0.014	0.007	0.01	0.2	0.4	0.3	0.5	0.2	0.0005	〃
S	0.13	1.3	0.8	0.15	0.046	0.016	0.005	0.02	0.4	0.5	0.5	0.9	0.8	0.0011	〃
T	0.11	1.1	1.0	0.15	0.051	0.015	0.004	—	—	—	—	—	—	—	〃
U	0.11	1.1	1.0	0.15	0.043	0.015	0.004	—	—	—	—	—	—	0.0006	〃

[0054]
[Table 2]

No.	加熱・冷却処理条件						備考
	鋼記号	昇温度速度 h_1 (℃/s)	均熱温度 T (℃)	均熱時間 t (s)	Ms点 (℃)	昇温度速度 s_1 (℃/s)	
1	A	5.2	770	18	485	10.8	適合例
2	B	6.8	760	16	479	12.5	〃
3	C	7.2	745	18	466	12.7	〃
4	〃	0.5	740	20	466	7.6	比較例
5	〃	5.8	700	16	466	10.2	〃
6	〃	5.2	810	16	466	15.3	〃
7	〃	6.5	754	0.5	466	10.6	〃
8	〃	6.5	758	26	466	11.2	〃
9	〃	6.5	752	18	466	2.8	〃
10	〃	5.9	760	18	466	14.8	適合例
11	〃	7.0	754	16	466	16.2	〃
12	〃	5.8	750	15	466	11.9	〃
13	〃	5.8	740	16	466	13.2	〃
14	〃	5.9	738	15	466	11.8	〃
15	〃	6.2	756	18	466	10.9	〃
16	〃	6.2	755	16	466	10.4	〃
17	D	6.5	750	17	445	11.5	〃
18	〃	6.1	751	15	445	9.2	適合例*1
19	〃	6.0	748	14	445	7.6	〃 *2
20	E	5.4	735	17	423	14.7	〃
21	F	5.6	772	11	501	10.8	比較例
22	G	5.8	754	9	445	10.2	〃
23	H	6.4	748	13	496	11.4	〃
24	I	6.2	751	11	482	9.5	〃
25	J	5.4	740	14	474	8.6	〃
26	K	5.9	764	11	477	8.5	適合例
27	L	11.4	741	7	471	12.5	〃
28	M	6.2	752	15	460	11.6	〃
29	N	6.1	742	17	463	10.4	〃
30	O	7.2	746	16	438	10.1	〃
31	P	8.4	738	18	444	9.5	〃
32	Q	4.2	748	20	434	10.5	〃
33	R	5.1	742	15	434	8.5	〃
34	S	5.2	741	15	427	9.2	〃
35	T	5.2	741	15	476	9.2	〃
36	U	5.2	741	15	476	9.2	〃

*1 冷却工程途中で溶融亜鉛めっき処理を施した。
*2 冷却工程途中で溶融亜鉛めっき処理を施し、冷却処理終了後に亜鉛めっきの合金化処理を施した。

[0055] From the center section of the coil longitudinal direction of the steel plate obtained in this way, the sample for steel organization observation and the JIS No. 5 test piece were cut down, and observation of a steel organization and a tension test were presented. An organization observation result and a tension test result are shown in Table 3.

[0056]

[Table 3]

No.	鋼組織					材料特性					備考
	フェライト粒径 (μm)	第2相組織 *3	第2相占積率 (vol%)	第2相形態	第2相平均幅 (μm)	YS (MPa)	TS (MPa)	YR (%)	El (%)	TS×El (MPa・%)	
1	2.3	M+A	8	網目状	0.3	416	612	68	35	21420	適合例
2	2.1	M+A	9	網目状	0.3	439	665	66	33	21945	〃
3	1.8	M+A	14	網目状	0.2	484	745	65	30	22350	〃
4	2.7	M+A	17	網目状	0.4	495	687	72	29	19923	比較例
5	1.8	M	2	塊状	—	419	554	64	30	16620	〃
6	3.6	M+B	35	網目状	0.8	531	781	68	24	18744	〃
7	1.9	M	3	塊状	—	436	660	66	30	19800	〃
8	3.1	M	19	塊状	—	443	652	68	30	19560	〃
9	1.8	M+B	17	網目状	0.3	473	630	75	27	17010	〃
10	1.8	M+A	18	網目状	0.3	483	721	67	30	21630	適合例
11	1.9	M+A	16	網目状	0.3	485	735	66	29	21315	〃
12	2.0	M+A	15	網目状	0.4	472	726	65	30	21780	〃
13	1.8	M+A	13	網目状	0.3	490	742	66	29	21518	〃
14	1.8	A	11	網目状	0.2	467	730	64	31	22630	〃
15	1.7	M+A	17	網目状	0.3	495	728	68	30	21840	〃
16	1.8	M+A	15	網目状	0.3	482	730	66	29	21170	〃
17	1.7	M+A	12	網目状	0.2	474	707	67	31	21917	〃
18	1.8	M+A	15	網目状	0.3	462	700	66	31	21700	〃
19	1.9	M+A	14	網目状	0.3	461	698	66	31	21638	〃
20	1.5	M+A	18	網目状	0.3	536	824	65	26	21424	〃
21	3.5	M+B	38	網目状	0.6	444	569	78	31	17639	比較例
22	1.8	M+B	4	塊状	—	449	591	76	30	17730	〃
23	1.9	M+B	14	網目状	0.3	472	638	74	30	19140	〃
24	4.5	M	9	網目状	0.3	425	625	68	32	20000	〃
25	1.7	M+A	18	網目状	0.3	536	734	73	25	18350	〃
26	2.3	M+A	9	網目状	0.3	428	658	65	33	21714	適合例
27	2.0	M+A	13	網目状	0.3	441	649	68	33	21417	〃
28	1.8	M+A	14	網目状	0.2	442	660	67	32	21120	〃
29	1.9	M+A	12	網目状	0.3	439	645	68	34	21930	〃
30	1.7	M+A	13	網目状	0.3	421	648	65	34	22032	〃
31	2.1	M+A	11	網目状	0.3	430	672	64	35	23520	〃
32	1.7	M+A	16	網目状	0.3	427	647	66	33	21351	〃
33	1.9	M+A	14	網目状	0.3	448	689	65	31	21359	〃
34	1.5	M+A	15	網目状	0.3	449	680	66	32	21760	〃
35	1.8	M+A	14	網目状	0.3	437	652	67	33	21516	〃
36	1.6	M+A	14	網目状	0.3	439	655	66	33	21615	〃

*3 M：マルテンサイト、A：残留オーステナイト、B：ベイナイト

[0057] Each steel plate manufactured according to this invention has obtained the target steel organization, consequently the low yield ratio of YR<=70% combines it, and it is obtained by the good on-the-strength-elongation balance and the coincidence TSxEl>=21000MPaand% so that clearly from Table 1, 2, and 3. In addition, since each example of adaptation of this invention had added Ti, an organization is a particle size regulation and it was checked that an anisotropy is also small.

[0058]

[Effect of the Invention] According to this invention in this way, TSxEl . With the good on-the-strength-elongation balance property more than 21000 MPa and %, YR can obtain the low yield ratio of 70% or less collectively, and lightweight-ized ****** of an automobile does **** so to improvement in energy efficiency.

[Translation done.]